

CLAIMS:

What we claim as our invention is:

1. A method for receiving electromagnetic radiation from a signal transmitter in the presence of a source of electromagnetic noise in a borehole telemetry system comprising:
 - aligning a directional signal sensor with a field produced by an electromagnetic signal transmitter in a borehole,
 - aligning a directional noise sensor with a field produced by a source of electromagnetic noise, and
 - using an output from the noise sensor to remove noise from an output of the signal sensor.
2. A method according to Claim 1, further comprising:
 - coupling an output of the signal sensor to a signal input of a noise cancellation system,
 - coupling an output of the noise sensor to a noise input of the noise cancellation system, and
 - using the noise cancellation system to produce a signal with reduced noise content.
3. A method according to Claim 1, further comprising using a three-axis sensor as the signal sensor and aligning the signal sensor by weighting and summing the outputs of the three-axis sensor.

4. A method according to Claim 1, further comprising using a three-axis sensor as the noise sensor and aligning the noise sensor by weighting and summing the outputs of the three-axis sensor.
5. A method according to Claim 1, further comprising:
 - using one three-axis sensor as both the signal sensor and the noise sensor,
 - aligning the signal sensor with a field produced by a signal transmitter in a borehole by weighting and summing the outputs of the three-axis sensor,
 - and
 - aligning the noise sensor with a field produced by a noise source by weighting and summing the outputs of the three-axis sensor.
6. In a borehole telemetry system of the type in which an electromagnetic transmitter in a borehole transmits an electromagnetic signal, a signal sensor detects the transmitted signal in the presence of a source of electromagnetic noise, and a noise sensor detects electromagnetic noise, the improvement comprising using a directional signal sensor aligned with a field transmitted by an electromagnetic transmitter in a borehole to detect the electromagnetic signal.
7. The system of Claim 6, further comprising using a noise sensor to detect electromagnetic noise.
8. The system of Claim 7, further comprising using an output from the noise sensor to remove noise from the detected electromagnetic signal.

9. The system of Claim 8, further comprising using a directional noise sensor aligned with a field produced by the source of electromagnetic noise to detect the electromagnetic noise.
10. The system of Claim 9, further comprising using three orthogonal directional sensors to detect fields produced by the source of electromagnetic noise, and weighting and summing the outputs of the three sensors to provide a sensor in alignment with a field produced by the source of electromagnetic noise.
11. The system of Claim 6, further comprising using three orthogonal directional sensors to detect fields produced by the electromagnetic transmitter, and weighting and summing the outputs of the three sensors to provide a sensor in alignment with a field produced by the electromagnetic transmitter.
12. In a borehole telemetry system of the type in which an electromagnetic transmitter in a borehole transmits an electromagnetic signal, a signal sensor detects the transmitted signal in the presence of a source of electromagnetic noise, and a noise sensor detects electromagnetic noise, the improvement comprising using a directional noise sensor aligned with a field generated by a source of electromagnetic noise to detect the electromagnetic noise.
13. The system of Claim 12, further comprising using a signal sensor to detect a signal transmitted by an electromagnetic transmitter.
14. The system of Claim 13, further comprising using an output from the noise sensor to remove noise from the detected electromagnetic signal.

15. The system of Claim 14, further comprising using a directional signal sensor aligned with a field produced by the electromagnetic transmitter to detect the electromagnetic signal.
16. The system of Claim 15, further comprising using three orthogonal directional sensors to detect fields produced by the electromagnetic transmitter, and weighting and summing the outputs of the three sensors to provide a sensor in alignment with a field produced by the electromagnetic transmitter.
17. The system of Claim 12, further comprising using three orthogonal directional sensors to detect fields produced by the source of electromagnetic noise, and weighting and summing the outputs of the three sensors to provide a sensor in alignment with a field produced by the source of electromagnetic noise.
18. Apparatus for receiving electromagnetic radiation from a source of electromagnetic radiation in a borehole telemetry system comprising a directional sensor positioned in alignment with a field generated by a source of electromagnetic radiation.
19. Apparatus according to Claim 18 wherein the sensor is a magnetometer aligned with a magnetic field generated by the source of electromagnetic radiation.
20. Apparatus according to Claim 18 wherein the sensor is an antenna aligned with an electric field generated by the source of electromagnetic radiation.

21. Apparatus for transmitting electromagnetic signals from a borehole to a surface location comprising;
- an electromagnetic transmitter in a borehole; and
 - a directional sensor aligned with a field produced by the transmitter near the surface location of the borehole.
22. Apparatus according to Claim 21 wherein the directional sensor is a magnetometer aligned with the direction of the magnetic field of signals from the electromagnetic transmitter.
23. Apparatus according to Claim 21 wherein the directional sensor is an antenna aligned with the direction of the electric field of signals from the electromagnetic transmitter.
24. Apparatus for removing noise from electromagnetic signals received in a borehole electromagnetic telemetry system comprising a noise sensor aligned with a field produced by a source of electromagnetic noise.
25. Apparatus according to Claim 24 wherein the sensor is a magnetometer aligned with a magnetic field generated by the source of electromagnetic noise.
26. Apparatus according to Claim 25 wherein the sensor is an antenna aligned with an electric field generated by the source of electromagnetic noise.

27. Apparatus for receiving data transmitted by an electromagnetic transmitter in a borehole in the presence of a source of electromagnetic noise comprising;
- a directional signal sensor aligned with a field generated by the electromagnetic transmitter;
 - a directional noise sensor aligned with a field generated by the source of electromagnetic noise; and
 - a noise canceller having inputs coupled to the signal sensor and the noise sensor and having an output providing a signal with reduced noise content.
28. Apparatus according to Claim 27 wherein the signal sensor is a magnetometer aligned with the magnetic field produced by the electromagnetic transmitter.
29. Apparatus according to Claim 28 wherein the noise sensor is a electric field sensor aligned with the electric field produced by the source of electromagnetic noise.
30. Apparatus according to Claim 27 wherein the noise sensor is a magnetometer aligned with the magnetic field produced by the source of electromagnetic noise.
31. Apparatus according to Claim 30 wherein the signal sensor comprises an electric field sensor aligned with the electric field produced by the electromagnetic transmitter.